U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE
SUBCOMMITTEE ON ENERGY

HEARING CHARTER

The Impact of Federal Energy Efficiency and Renewable Energy R&D Programs

May 19, 2004
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building

1. Purpose

On Wednesday, May 19, 2004, the Subcommittee on Energy of the U.S. House of Representatives' Committee on Science will hold a hearing to examine the potential contribution of energy efficiency and renewable energy to the nation's energy needs. The hearing will focus on the contributions of the renewable energy and efficiency R&D programs at the Department of Energy.

2. Witnesses

Mr. Steven Nadel is the Executive Director of the American Council for an Energy-Efficient Economy (ACEEE), a non-profit research organization that works on programs and policies to advance energy-efficient technologies and services.

Mr. Paul Konove is President of Carolina Country Builders of Chatham County Inc., a company that specializes in custom solar home design and construction.

Ms. Vivian Loftness is Head of the School of Architecture at Carnegie-Mellon University. Her design and consulting work has led to the design and construction of numerous energy conserving buildings here and abroad.

Mr. John B. Carberry is Director of Environmental Technology for the DuPont Company in Wilmington, Delaware. His responsibilities include leading DuPont's efforts to find and use affordable renewable energy and energy efficiency technologies.

Mr. Peter Smith is President of the New York State Energy Research and Development Authority (NYSERDA).

Mr. Daniel L. Sosland is executive director of Environment Northeast, a non-profit research and advocacy organization, working on energy efficiency and renewable energy, climate change and air quality issues.

3. Overarching Questions

The hearing will address the following overarching questions:

- What are the likely U.S. energy needs for the coming decades? What is the potential for energy efficiency and renewable energy to help meet those needs?

- What are the public benefits of energy efficiency and renewable energy, and what is the proper role for the Federal government in helping to reap those benefits?

- How have energy efficiency improvements contributed to meeting current energy demands? What programs at the State and Federal level, along with programs implemented by industry, have been most successful at promoting energy efficiency and the use of renewable energy resources?

4. Overview

Over the past two decades, the U.S. has become increasingly dependent on foreign sources of energy, particularly oil and natural gas. The U.S. imported 27 percent of its energy (61 percent of its petroleum, of which 70 percent is used for transportation) in 2001. Assuming that current conditions continue into the future, often referred to as a "business-as-usual" scenario, imports are projected to grow to 39 percent of total energy use, and 76 percent of petroleum use by 2025.[1] As the country looks to reduce its dependence on imported energy, there are four potential options: increase the nation's energy efficiency, increase the domestic production of fossil fuels, increase the use of nuclear power, and increase the use of renewable energy. All of these options face unique challenges to provide the 136 quadrillion BTU's the United States is projected to use in 2025. In fact, it is likely that only a combination of approaches will yield enough energy to sustain economic growth.

Most experts agree that if the United States is going to reduce its dependence on imported energy, renewable energy and energy efficiency will need to meet an increasing percentage of energy demand in the United States over the next 20 years. This is particularly true in the near-term since energy efficiency improvements can reduce demand more quickly than longer-term development of new sources of nuclear or fossil-based energy can expand supply. Many of the additional public benefits attributable to energy efficiency and renewable energy, such as reduced emissions and better peak-load management, are not reflected in their price to consumers.

Energy efficiency is better management of processes, equipment, personnel, and other resources to reduce energy use. For example, by actively managing their energy-intensive industrial processes, the DuPont Company has kept energy use constant since 1990, while production has increased by 40 percent over the same period. Although accelerated efficiency improvements could make a significant impact on demand, there will still be a need for new sources of energy. To meet the growth in demand, the U.S.

[1] *Annual Energy Outlook 2004*, p 133. Energy Information Administration.

will require a mix of energy sources, including renewable energy resources. Renewable energy sources such as wind and solar power are competitive in some markets—particularly sunny or windy areas, regions with high energy costs, or specific niche applications—but some expert suggest, that with additional technology improvements, wind and solar power could be cost-competitive in nearly all regions of the country.

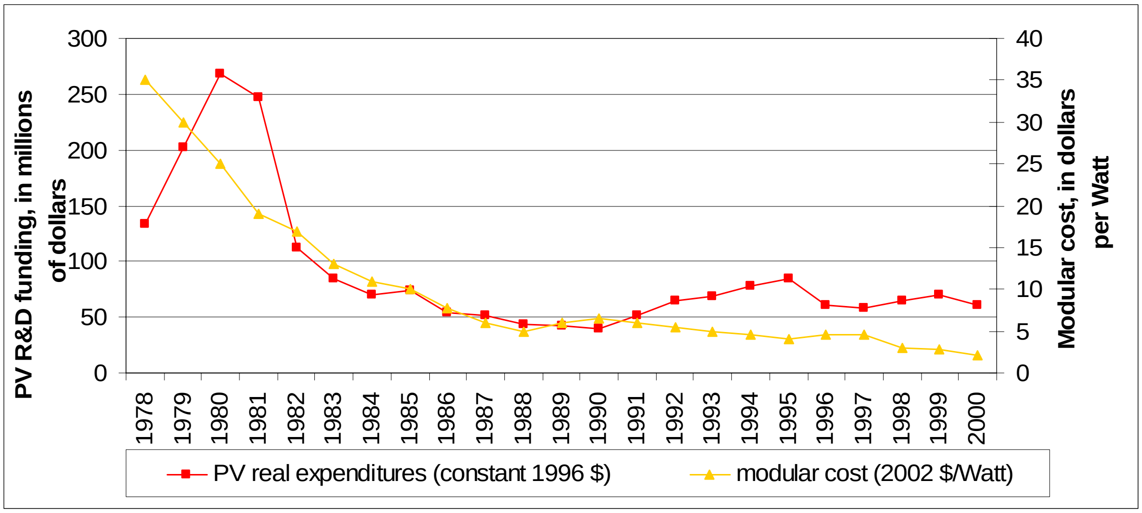
Market Barriers

There are significant market barriers to the wider use of energy efficiency and renewable energy to reduce overall demand and substitute for imported energy. Conventional energy technologies have a head start in terms of experience and existing infrastructure, and end-users who might invest in renewable energy and energy efficiency technology do not always realize the full benefits of their investments under current market structures. A familiar example is the landlord-tenant problem, where the landlord who pays for efficiency upgrades does not receive the benefits of the investment; savings go to the occupants of a building who pay the energy bills.

When electricity consumers do improve their end-use efficiency, results can be dramatic. In fact, upgrading the energy efficiency of existing facilities is often less expensive than installing new generating and transmission capacity. According to experts, efficiency improvements often produce co-benefits. More efficient lighting, for example, can reduce cooling costs and improve productivity. Including the savings from reduced energy costs and co-benefits, efficiency improvements can actually provide a return of up to 4 cents per kilowatt-hour (¢/kWh). Even without co-benefits, lighting, refrigeration, and space heating improvements typically cost between 0-3 ¢/kWh, well below the average cost of electric power. Additionally, there are numerous public benefits from these kinds of improvements. Avoided emissions, reduced infrastructure requirements, reduced sensitivity to fuel-price volatility, and reduced physical disturbances to the energy system, are benefits to the public that are generally not included in the costs borne by consumers.

For renewable energy, the primary barrier is cost. Renewable energy is also relatively immature compared to other energy technologies. Immature technologies tend to fall in cost faster than conventional technology because manufacturers have less knowledge and experience working with them. Therefore Federal R&D investments and production incentives can have a large impact on immature technologies, by helping manufacturers reduce costs. For example, Figure 1 shows Federal support for photovoltaics R&D and the cost reductions in photovoltaic solar modules that occurred over the same period of time, although it is difficult to isolate the impacts of Federal spending from other factors. Similar cost reductions over time are seen for other renewable energy technologies.

Figure 1 – Solar Photovoltaic (PV) Energy Cost and Real Federal R&D Spending



Another barrier to accelerated market penetration of renewable energy resources is the fact that their lower environmental impact is not reflected in the price of energy. Although the economic value of the environmental impacts of energy use is difficult to quantify, some estimates of the full cost of energy technologies calculate the total costs of renewable energy as lower than the total current cost of conventional technologies.[2]

Another benefit of energy efficiency and renewable energy is their capacity to reduce the peak demand for electricity and natural gas. By displacing the usage of peak generation plants (which are typically the most expensive to operate, the least efficient, and have higher emissions) the use of energy efficiency and renewable energy technologies can lower the price of electricity and natural gas for all consumers, whether or not they directly purchase renewable power or an energy efficient appliance. Both the National Petroleum Council and the American Council for an Energy Efficient Economy have cited energy efficiency as a key step in reducing natural gas prices in the short term, and reducing price volatility in the longer term.

R&D Funding

Energy efficiency program funding has varied over the years, peaking, along with energy prices, in the early 1980s. Recently, efficiency R&D programs have been flat-funded at best, with efficiency R&D programs cut by 10 percent ($63 million) in the President's Fiscal Year 2005 (FY05) budget request. These funding cuts are proposed even though energy efficiency R&D funding has been shown to be highly cost-effective. In response to a Congressional request to examine the effectiveness of DOE's energy efficiency programs, a National Academy of Sciences study estimated that for every dollar spent on all efficiency programs between 1978 and 2000 more than four dollars of economic benefits were realized. For example, the Academy estimated that the benefits from efficient lighting research returned $5.3 billion to the public in the form of lower energy

[2] *"Electricity Generation and Environmental Externalities: Case Studies September 1995,"* p.44, Energy Information Administration

bills, while the cost of this research was only $2.5 million, including $755,000 paid by industry. Renewable energy has fared better, increasing by 5 percent in the FY05 request, although the largest increase is requested for the hydrogen and fuel cell programs.

Table 1: Science Committee Analysis of Efficiency and Renewable Energy Research and Development funding Trends.

	FY03 appropriation (in millions)	**FY04 appropriation (in millions) ***	**FY05 Request (in millions)**	**$ Change from FY04 Level**	**% Change from FY04 Level**
Office of EE and RE	$1,202	$1,235	$1,251	$18	1.4%
Weatherization and state grants	$268	$271	$332	$61	23.0%
EE R&D	$612	$607	$544	-63	-10.1%
RE R&D	$322	$357	$375	17	4.5%
EERE R&D total	$934	$964	$919	-$45	-4.7%
Hydrogen and FreedomCAR	$176	$237	$264	$27	12.0%
EERE R&D **other than** H2 and FreedomCAR	**$756**	**$727**	**$655**	**-$72**	**-9.9%**

* The figures in this chart include all appropriated amounts for FY 04.

6. Background

Energy Efficiency

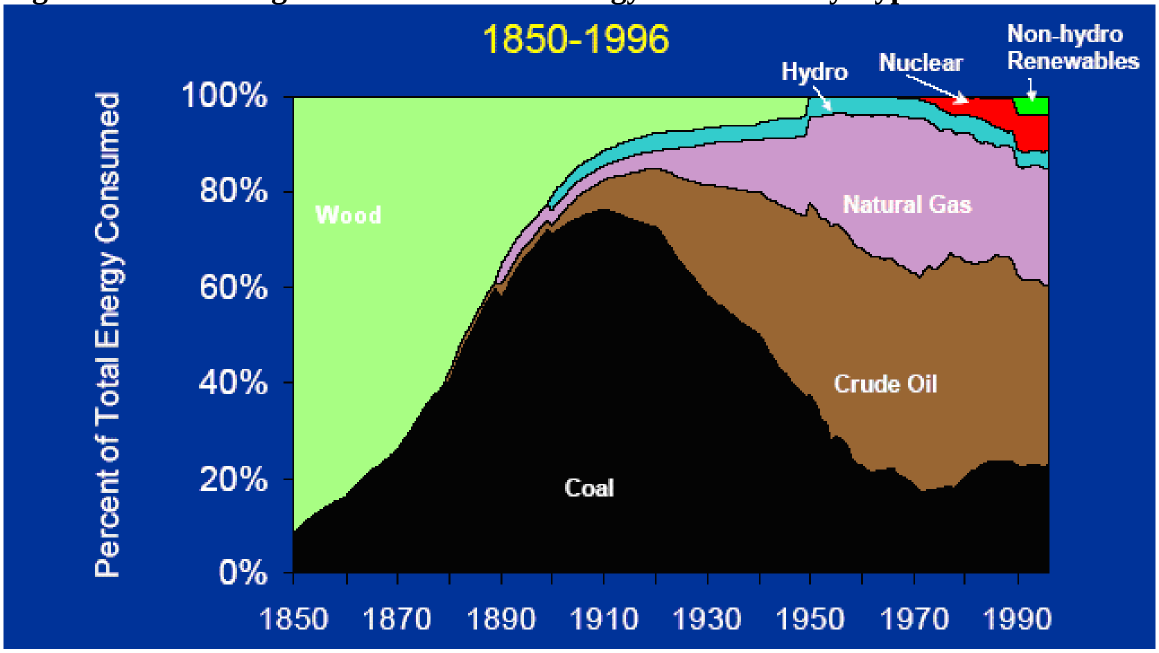
Historically, energy efficiency improvements have reduced the need for more energy production. Energy intensity (energy consumed per unit of output) has improved by an average of 1 to 2 percent per year in the U.S. The International Energy Association (IEA) estimates that without the improvements made since 1973 in processing and using energy, world energy use in the year 2000 would have been 50 percent higher—in the U.S. this would be approximately 50 quadrillion BTU's (quads). When a concerted effort is made to improve energy efficiency, reductions in demand can be even larger. Several states have implemented their own programs, with excellent results. New York State reduced energy intensity by average 2.7 percent per year from 1977-1999, and some states have realized annual efficiency improvements greater than 3 percent. Federal facilities spent $6 billion less in 2001 than they did in 1985 (in constant 2001 dollars), and used 31 percent less energy, in part due to improved energy efficiency.

Energy efficiency improvements can be realized relatively quickly, since there are no delays for siting and construction. In several state programs, utilities have discovered that paying customers to reduce demand is less expensive than building new generation equipment. On a cost per kilowatt-hour basis, efficiency improvements are often the least expensive form of “new generation.”

Renewable Energy

Renewable energy generation currently represents a small fraction of the energy portfolio in the U.S., but it is growing rapidly. As Figure 2 shows, at the turn of the last century, oil and gas had limited market shares, but were able to dominate the market within fifty years. Wind and solar photovoltaics have the fastest growth rates in the electricity industry worldwide, with wind generation rates growing at roughly 35 percent per year, and photovoltaics growing at 25 percent per year. Japan is leading the pack by installing 219 Mega-Watts (MW) of solar photovoltaic generating capacity in 2003 alone.

Figure 2 – Percentage Market Share of Energy Production by Type 1850-1996.



Source: NREL and Dept. of Interior

There are also signs in Europe that renewables can supply a large fraction of electrical power. In some regions of Spain and Germany, and all of Denmark, wind supplies more than 10 percent of the electricity demand throughout the year, and in some states in Germany wind provides over 50 percent of local electricity needs for certain months.

As a consequence of aggressive government programs to support wind and solar power technology development and deployment, the Japanese and European manufacturers’ market shares of wind and solar power generation equipment have increased dramatically, while the U.S. manufacturers’ market share has declined. Japan’s share of the world solar photovoltaics market went from 26 percent to 49 over eight years from 1995 to 2003, while U.S. share of the world market went from 45 percent in 1996 to 12 percent in 2003. Similar declines in the U.S. share of the world market for wind equipment can be seen, with the majority of the increases captured by European manufacturers.

Current Activities

Despite the barriers, numerous companies, individuals and government entities have invested in efficiency improvements and renewable energy and have seen large returns. Dupont has kept energy use constant since 1990, while production has grown 40 percent, for a savings of $1.5 billion. This type of success has been replicated in other companies and industrial sectors, with large corporations such as BP (the international energy firm), IBM, Kimberly-Clark and others setting efficiency as a high-priority goal for improving profitability. In the buildings sector, efforts by the joint Environmental Protection Agency (EPA)-Department of Energy (DOE) EnergyStar® program and voluntary standards released by the Green Building Council, an independent non-governmental organization, have contributed to growth in the high-efficiency buildings market. These efforts have also expanded the market for onsite renewable generation.

State governments have also taken an active role in promoting efficiency and renewables. In response to calls for conservation during the electricity crisis of 2000 and 2001, consumers' efficiency efforts produced a 10 percent reduction in demand in less than a year. California is currently promoting demand response and energy efficiency technologies to meet demand before considering new fossil generation. More generally, several states with strong efficiency programs were able to reduce energy intensity by more than 3 percent per year from 1977-1999.

The Federal government has several current activities aimed at increasing the use of highly efficient and renewable technologies. These include the R&D in the Office of Energy Efficiency and Renewable Energy (EERE) at DOE, with a funding request of $919 million in 2005. This amount represents a proposed decrease in the FY 2005 budget request, by 10 percent ($63 million) versus current spending. Renewable energy has fared better, increasing by 5 percent in the 2005 budget request, although the largest increase was for the hydrogen and fuel cell programs. As Table 1 shows, non-hydrogen research in EERE would decline by 10 percent under the Administration's request.

The Federal government has also set efficiency standards for several appliances in recent years, which have resulted in large reductions in demand. The benefits have been significant, reducing residential heating, cooling and refrigeration energy use by 25 percent, 60 percent, and 75 percent respectively.[3] Four pending standards are expected to save consumers $10 billion in energy costs by 2010.[4] Federal tax incentives for electricity produced from wind are credited by experts with boosting the market share of wind generation, although the wind production tax credit expired on December 31, 2003.

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[3] Rosenfeld, Arthur H., Pat McAuliffe, and John Wilson. "Energy Efficiency and Climate Change." *Encyclopedia on Energy,* edit. Cutler Cleveland, Academic Press, Esevier Science, 2004.
[4] Loftness, V. "Improving Building Energy Efficiency in the U.S.: Technologies and Policies for 2010 to 2050", proceedings of *The 10-50 Solution: Technologies and Policies for a Low-Carbon Future.* Pew Center on Global Climate Change and the National Commission on Energy Policy.

Incentives for wind and other renewable generation, as well as credits for highly efficient technologies, are included in several legislative proposals, including H.R. 6, the Energy Policy Act of 2003.

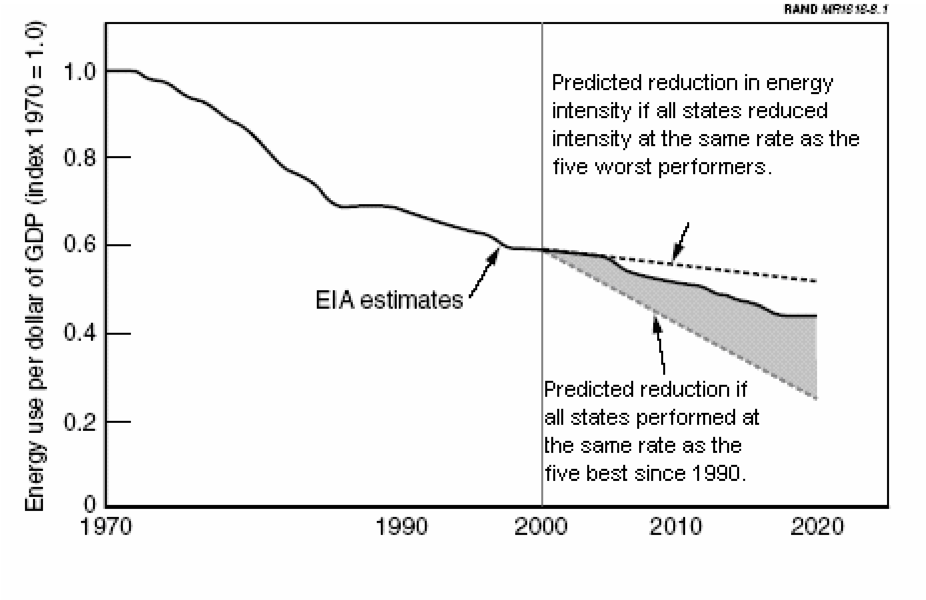
The Federal government has also attempted to lead by example in the marketplace. Federal purchases of renewable energy totaled 362 gigawatthours (GWh) in 2001, with a goal of 2.5 percent of electricity use by 2005, or 1,384 GWh. By an Executive Order issued in 1999, which the Bush Administration has continued to implement, Federal buildings are required to improve their energy efficiency by 30 percent by 2005, and 35 percent by 2010 compared with baseline energy use in 1985. By creating a market for energy efficient and renewable technologies, the government can use its purchasing power to lower the technology adoption costs for other consumers.

Potential

If all states promoted energy efficiency as successfully as the five best states, the reduction in energy intensity (defined as unit of production per unit of energy consumed) would be 2.4 percent per year, a 50 percent improvement over current annual projections.[5] If this level could be sustained, the savings in 2020 would be the equivalent of 3.4 billion barrels of oil.

[5] The Energy Information Administration is the most commonly cited source for domestic energy demand projections. All of its base projections, to ensure consistency, assume no changes in policy. The projections also do not account for variations in R&D spending.

Figure 3 – Best and Worst-Case Efficiency Scenarios Based on Past State Performance



Source: RAND

Some of the most impressive benefits come from the *combination* of renewables and efficiency. High efficiency homes with solar power systems on the roof are allowing the creation of homes with near zero energy bills. Some of the larger home-building firms are offering high efficiency and "zero-energy" homes, even creating planned communities of entirely Energy-Star homes, which are high-efficiency homes certified by the EPA.

The primary goal of the renewables programs at DOE is to reduce costs so that renewable technologies can be competitive in the market without further government subsidies. Wind technology is already competitive in areas with the highest wind speed, but further reductions are needed to make wind a viable power source in lower wind speed regions.

7. Questions for the Witnesses

Questions for Mr. Steve Nadel:

1. What is the potential contribution of energy efficiency to meeting future national energy needs? What is the potential for renewable energy? What portion of that potential is cost-effective today, and what portion would require additional research or other incentives?

2. What are the impacts of increased energy efficiency and renewable energy on the natural gas market?

3. What federal and state policies have been successful in encouraging efficiency and renewable energy? What state efforts could be expanded to a federal level?

4. What would be the most cost-effective way for the Federal government to encourage the use of energy efficiency and renewable energy technologies?

Questions for Mr. Paul Konove:

1. What are the key technology improvements that can result in cost-effective energy savings in today's homes and buildings? Are there renewable energy technologies that can be utilized in new construction in cost-effective manner?

2. What has your experience been with constructing high efficiency buildings? What have been the successes, and the challenges?

3. What areas of energy efficiency and renewable energy technologies need research to improve their operation or cost-effectiveness? What technologies are ready for the marketplace but need improved technology transfer to be widely adopted?

4. How do energy efficiency improvements in new construction differ from retrofitting older buildings? Given that about half the housing we expect to have in the year 2025 has not yet been built, what contribution can improved technologies make toward reducing the energy demands of the future housing stock?

Questions for Ms. Vivian Loftness:

1. What portion of U.S. energy demand do buildings consume? How is that divided among lighting, heating and other major appliances? What are the relative shares of commercial, residential, and industrial building consumption?

2. The Energy Information Administration predicts that energy demand will grow from about 100 quadrillion BTU (quads) in 2000 to 136 quads in 2025. Taken together, what portion of the 36 percent projected growth in energy demand to 2025 would be attributed to buildings? What proportion of that demand could be met by efficiency investments?

3. What are the greatest opportunities that have not yet been fully explored in Federally-sponsored energy efficiency research? Given historical results, what would you estimate the economic rate of return to R&D funding to be?

Questions for Mr. John B. Carberry:

1. Which Federal energy efficiency and renewable energy programs has DuPont found to be successful? What benefits has DuPont seen from these efforts?

2. What motivated DuPont to invest in energy efficiency and renewable technology? What Federal programs and regulations encouraged or hampered that investment? How should the Federal government improve its efforts?

3. What is the potential for further efficiency improvements at DuPont? In your opinion, what are the potential impacts of efficiency improvements and the use of renewable resources in the industrial sector on national energy demand? How replicable are the gains made at DuPont? Are any of the improvements considered proprietary? If so, do you license them?

4. How can efficiency improvements and the use of renewable energy throughout the economy affect natural gas prices in the U.S.? How have increased natural gas prices affected DuPont's decisions about plant location?

Questions for Mr. Peter Smith:

1. Why did Governor Pataki feel that it was important to make a commitment to improving New York's energy efficiency, and to increasing the use of renewable energy? What benefits has New York State seen from these efforts? How much did the programs cost?

2. How does New York State measure the effectiveness of its investments in energy efficiency and renewable energy technologies? Does New York State involve industry in its research, and if so how is industry involved? Is industry required to share research costs?

3. What are the potential synergies between state and federal efforts? Are these areas being fully exploited? How can federal efforts be improved? Are there any state policies that should be adopted at the federal level?

4. What are other states doing to promote energy efficiency and renewable energy?

Questions for Mr. Daniel L. Sosland:

1. Why did the Connecticut Legislature feel that it was important to make such a strong commitment to energy efficiency standards, and to increasing the use of renewable energy? What benefits do you expect to see from these efforts? How much are the programs projected to cost?

2. How does the State of Connecticut measure the effectiveness of its investments in energy efficiency and renewable energy technologies? Does the State of Connecticut involve industry research in its efforts, and if so how is industry involved? Is industry required to share research costs?

3. What are the potential synergies between state and Federal efforts? Are these areas being fully exploited? How can Federal efforts be improved? Are there any state policies that should be adopted at the Federal level? What are other states doing to promote energy efficiency and renewable energy?

4. What are technology opportunities that have not yet been fully explored in Federally-sponsored energy efficiency research?